

**The occurrence of certain natural cross-breds in Oats and Barley
at the State Experiment Farm, Merredin, Western Australia.**

By **W. M. Carne**, Botanist, Department of Agriculture, and
E. J. Limbourn, State Experiment Farm, Merredin.

(Read March 11, 1924.—Issued March 31, 1924.)

The common cereals—wheat, oats, and barley—are normally self-pollinated. Natural crossing is so rare that it is the rule for plant breeders to grow different varieties in closely adjoining rows without any particular precautions against cross-pollination. Nevertheless, natural cross-breeding does sometimes occur, especially in climates warm and dry at flowering time (2).*

Natural cross-breeding in cereals has been recorded from Experiment Stations elsewhere. Natural crossing in wheat is discussed in an article by Pridham (4), who also gives evidence of its occurrence in Australia. Percival (1) says of 1,400 varieties of wheat grown over some years at Reading, England, that some five or six natural cross-breds occur annually. Howard (2), in India, has recorded 231 natural crosses in wheat. At the University Farm, St. Paul, Minnesota, two or three per cent. of natural crosses occur each year (2). Pridham, in New South Wales, has recorded (3) a natural cross between Skinless and Algerian oats. He is also of opinion (3) that the variety of oats known as "Sunrise" originated in a natural cross which appeared in a crop of Algerian oats. Records of such crosses in barleys are few (2, 8). Hayes and Garber (2) conclude that the available evidence indicates that wheat cross-fertilises more readily than either oats or barley.

ALGERIAN \times SKINLESS OATS.

(*Avena sterilis* \times *Avena nuda*.)

Algerian oats are characterised by strong, horny, dark-coloured flowering glumes which are closely adherent to the caryopses. The spikelets are normally biflorous, occasionally triflorous. A pubescence occurs at the base of the lower grain of each spikelet. The lower grain is also strongly awned.

Skinless oats have large membranous white or yellow flowering glumes which are not adherent to the caryopses, and the latter are, therefore, described as skinless or naked. The spikelets are multi-

* Numbers in parentheses refer to the bibliography at the end of this paper.

florous, containing three to five flowers. There is an almost complete absence of awns and of pubescence at the base of the grains. At Merredin, Skinless oats flower about ten days later than Algerian.

In 1921 a plant appeared in a row of Algerian oats in the variety test rows at the Merredin Experiment Farm. It was distinguished by the presence of multiflorous spikelets, resembling those of Skinless oats, in the upper portions of the panicles. In the lower portions the spikelets were biflorous and similar to those of Algerian oats. The remainder and majority of the spikelets were intermediate between the two. Seed of this plant sown in 1922 matured only four plants. Of these, one (A) resembled Skinless oats in the character of the spikelets; another (B) resembled Algerian, and two (C) the parent. In 1923 the plants from (A) continued to resemble Skinless; those from (B) Algerian, while from (C) came plants resembling A, B, and C.

Unfortunately, all plants of the last generation were not kept; but there is sufficient evidence to indicate that the original plant was the product of a cross between Algerian and Skinless oats, with the F-1 generation intermediate between both parents, without dominance as regards the number of flowers in the spikelet or hull character. The F-2 generation gives the simple Mendelian ration of 1 : 2 : 1. This agrees with the known results when such a cross is artificially made (2, 5, 6). A similar but reciprocal natural cross was recorded by Pridham (3) at Cowra, New South Wales, in the following words: "A remarkable plant, which from its behaviour, is evidently a natural cross-bred, appeared in 1913 in a plot of Chinese Skinless oats. It was much earlier than the type, and the early stools bore spikes in which the upper spikelets resembled the naked or Skinless oat—three to five flowers to a spikelet; while the lower were like the Algerian oat, with dark-brown hulls and two flowers to a spikelet. Two late stalks had a paler foliage and bore flowers typical of the Skinless oat. Next year the progeny comprised plants which were wholly like Algerian, others exactly like Skinless, and many intermediate in character, showing both hulled and naked grain in the same plants. In 1915 similar variations were found . . ." From the material saved it is evident that segregation had also gone on in respect to grain colour, pubescence and time of flowering; but it is not possible to work out the ratios. The evidence appears to support the findings of Zinn and Surface (5) that the grain colour works out as a simple Mendelian factor but that pubescence is bifactorial, as many of the heterozygous plants have more pubescence than Algerian oats.

The intermediate spikelets of the heterozygous plants show all gradations between hulled biflorous and skinless multiflorous. The majority have two or three flowers with the glumes membranous, but with more or less adherent thickened midribs. The membranous glumes are more pronounced on the lower than the upper flower of the spikelets. There does not appear to be any constant relation

between the three types of spikelet in each head, though the intermediate types are the most numerous. There is no evidence of dominance as suggested by Von Tschermak and by Zinn and Surface (5), but the large glume influence of the skinless parent is so much more conspicuous than that of the thickened midrib effect of the hulled parent that there is an apparent, but not real, dominance of the skinless type.

It has been shown by various investigators (5, 6) that multiflorous spikelets are linked with skinless grains, and that it is therefore genetically impossible to produce a multiflorous hulled oat.

OTHER NATURAL CROSSES IN OATS.

Plants have been noted this season which are probably natural cross-breds between closely related varieties of oats. It is proposed to test these this year.

SKINLESS \times COMMON BARLEY.

(*Hordeum vulgare* var. *trifurcatum* \times *H. vulgare* var. *pallidum*.)

Skinless barley is characterised by six rows of spikelets in the head, with each outer flowering glume terminated by a trifurcate hood which appears to be a degenerate group of three spikelets in a reversed position. The caryopses are naked as in common wheat. The straw is yellow, and the grain light coloured.

Common barley has six rows of spikelets, but each flowering glume is terminated by a long awn. The grains are hulled. The straw varies from yellow to purple, and the grain from yellow to almost black.

In 1922 one plant of a hulled, hooded, purple-strawed barley with dark-coloured grain appeared in a row of Skinless barley. In 1923 seed from this plant produced hooded, awned and intermediate types. Differences were also noted in regard to hull character, straw colour and grain colour. As regards awns, the intermediate types have short awns terminated by a hood.

It is unfortunate that all plants were not kept. It is known, however, from artificial crosses (2) that hulled grain is dominant over skinless, and that in the F-1 generation the awns are intermediate, i.e. with hoods on short awns. In the F-2 generation, hull character works out as: 3 hulled; 1 skinless and, as to awns, 1 awned; 2 intermediate; 1 hooded. The evidence indicates that a natural cross took place, probably in 1921, between Skinless and a purple-strawed dark-grained common barley. A similar natural cross has been recorded by Harlan (8) in America.

The same results were obtained at Merredin from seed of a grass clump plant found in Skinless barley in 1922, which produced the different types already mentioned and also grass clump plants which did not form ears.

SKINLESS × Two-rowed BARLEY.(*Hordeum vulgare* var. *trifurcatum* × *H. distichon*.)

Two-rowed or malting barley is characterised by the fact that only two (the centre of each group of three) of the six rows of spikelets are properly developed and set seed. The perfect flowers are awned, and the grain is hulled.

In 1920 a two-rowed skinless hooded barley was found in a row of Skinless barley. The progeny of this plant produced similar forms in 1921, 1922, and 1923. This form has no awns on the lateral spikelets, and has hoods on the central ones. Included among them in 1922 and 1923 were plants showing a tendency to become six-rowed, the upper portions of the ears setting seeds in the lateral spikelets. This type of barley is botanically known as *Hordeum intermedium* var. *cornutum* (8). It has been shown by Harlan and Hayes (9) that *H. intermedium* is a homozygous intermediate cross-bred (or rather hybrid) between six-rowed and two-rowed barleys.

It is believed that the plant found at Merredin in 1920 was a homozygous F-2 *intermedium* form, and that its progeny are fertile or potentially fertile *Hordeum intermedium* var. *cornutum*. The evidence indicates that a natural cross occurred between Skinless and a two-rowed barley, probably in 1919.

NATURAL CROSSES IN WHEAT.

On several occasions plants which appear to be natural crosses between varieties of wheat have been noted, but genetic proof has not been sought. It is proposed this year to grow the seed of several suspected cross-breds found during the past season.

SUMMARY.

Evidence is given that natural cross-breeding has, occasionally at least, taken place between markedly different varieties of oats and barley at Merredin. It is more than possible that natural crossing to a greater extent has also taken place between varieties more closely related, and more alike in appearance. The product of such crosses would not be nearly as conspicuous as those here recorded, and would be easily overlooked. Further, as wheat is apparently more ready to cross-fertilise naturally than oats or barley, natural crosses in wheat have probably occurred also, and, as in the common barleys and oats, would not be readily recognised. Plants which were the product apparently of natural crosses between closely related varieties of oats and wheat were noted during 1923. It is proposed to test these during the coming season.

BIBLIOGRAPHY.

1. Percival, John: The Wheat Plant, 1921.
2. Hayes, H. K., and Garber, R. J.: Breeding Crop Plants, 1921.
3. Pridham, J. T.: Agr. Gazette of N.S.W., XXVII., p. 458, 1916.
4. Pridham, J. T.: Agr. Gazette of N.S.W., XXXI., p. 457, 1920.
5. Zinn, J., and Surface, F. M.: Studies in Oat Breeding; Jour. Agr. Research, X., p. 293, 1917.
6. Stanton, T. R.: Naked Oats; Jour. Heredity, XIV., 4, p. 182, 1923.
7. Richardson, A. E. V.; Jour. Dept. Agri. Vic., XXI., p. 455, 1923.
8. Harlan, H. V.: The Identification of Varieties of Barley; U.S. Dept. Agr., Bur. Plant Indust. Bull. 622, 1918.
9. Harlan, H. V., and Hayes, H. K.: The occurrence of the fixed intermediate *Hordeum intermedium haxtoni* in crosses between *H. vulgare pallidum* and *H. distichon*; Jour. Agri. Research, XIX., pp. 575-591, 1920.

